ESTONIAN UNIVERSITY OF LIFE SCIENCES
Institute of Veterinary Medicine and Animal Sciences

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FELINE (*Felis catus*) JUVENILE HYPERPLASTIC GINGIVITIS: CASE SERIES STUDY

KASSIDE (*Felis catus*) JUVENIILNE HÜPERPLASTILINE GINGIVIIT: JUHTUDE SEERIA UURING

Final thesis
Curriculum in Veterinary Medicine

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Feline juvenile hyperplastic gingivitis is a distinct type of gingivitis affecting the domestic cat during puberty. The condition is dissimilar to typical gingivitis by having excessive erythematous gingival tissue creating deep pseudopockets. The aetiology is unknown, and there is a scarcity of scientific literature describing the condition. The disease can be frustrating as it often requires veterinary dental intervention more than once.

23 patient cases seen at the Small Animal Clinic of Estonian University of Life Sciences during November 2015 to March 2021 were analysed and a clinical characterization of the disease was assembled. The aim of this thesis is to bring awareness of the disease to veterinarians.

Keywords: veterinary dentistry, feline medicine, gingival pathology, juvenile disease

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Kasside juveniilne hüperplastiline gingiviit on kodukassidel murdeeas esinev spetsiifiline gingiviidi e. igemepõletiku vorm. Seisund erineb tavalisest gingiviidist ulatuslike erüteemsete igemevohandite esinemise näol, mille tõttu moodustuvad igemetel sügavad igemevao pseudotaskud. Seisundi etioloogia on teadmata ja seda käsitlevat teaduskirjandust on väga napilt. Tegemist on frustreeriva haigusseisundiga, kuna sageli esineb vajadus korduva veterinaarstomatoloogilise ravisekkumise järele.

Uuring koondab 23 Eesti Maaülikooli Väikeloomakliinikus 2015. a. novembrist kuni 2021. aasta märtsini diagnoositud ja/või ravitud patsiendi juhtumite kirjelduse ja analüüsi ning haigussündroomi kliinilise iseloomustuse. Töö eesmärgiks on loomaarstide teadlikkuse tõstmine selle haigusseisundi osas.

Märksõnad: veterinaarstomatoloogia, kasside meditsiin, igemete patoloogia, juveniilsed haigused

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LIST OF ABBREVIATIONS

COHAT - comprehensive oral health assessment and treatment

FCGS – feline chronic gingivostomatitis

FeLV – feline leukemia virus

FIP – feline infectious peritonitis

FIV – feline immunodeficiency virus

FJHG – feline juvenile hyperplastic gingivitis

post-op – postoperative

pre-op – before operation

SID – once a day (*semel in die*)

VLK – Small animal clinic of Estonian University of Life Sciences (*Väikeloomakliinik*)

INTRODUCTION

Most cats likely suffer from an oral cavity disease at some point during their lives. Common oral cavity diseases in cats include periodontal and dental diseases, neoplastic diseases, stomatitis, and ulcerative diseases. The prevalences of feline oral cavity and periodontal disease vary in the literature from 70-85% (Johnston, 1998) to 85-95% (Perrone, 2016), even up to 100% (Girard et al., 2009). Verhaert and Van Wetter (2004) found that 57% of the cats included in their study had periodontal disease and 25% had odontoclastic resorptive lesions. The differences in prevalence come from the mean age of the population studied, whether radiography was used as a diagnostic method, and which oral disease, or diseases, were studied. Regardless, all these numbers support the fact that oral diseases are very frequent in cats.

The occurrence of dental disease commonly increases with age. This is likely partly due to the lack of dental care provided for cats, as sometimes cats can be quite opposed to oral homecare, and the owners frequently lack understanding of the importance of oral health. For example, without consistent daily toothbrushing, dental and periodontal health deteriorate in time and thus we see more dental disease in aging cats. There are also oral cavity diseases that begin already at young age, one of them being feline juvenile hyperplastic gingivitis. Juvenile syndromes often lack scientific literature and the syndromes are often overlooked, partially possibly due to the misconception that youth equals good oral health. One of the purposes of this thesis is to bring awareness of the disease for veterinarians.

It is important for the veterinary practitioner to detect the juvenile oral diseases. According to Niemiec (2014), an untreated juvenile gingivitis predisposes the cat to further periodontitis which can lead to early tooth loss. An earlier diagnosis and intervention have better prognosis for healthy periodontal tissues also in the future. In addition, a dental disease is suggested to be a risk factor for developing chronic kidney disease in cats. (Finch et al., 2016). As with any chronic disease, having a less than optimal oral health decreases the cat's quality of life.

1. LITERATURE REVIEW

1.1. Gingivitis

Gingivitis is defined as an inflammation of gingival tissue, commonly a response to plaque bacteria (Perry and Tutt, 2015). Plaque consists of gram-positive aerobic bacteria supragingivally and of gram-negative anaerobic bacteria subgingivally (DeBowes, 2010). Other components of plaque are cellular debris, bacterial polysaccharides, and proteins present in saliva (Boyce, 1992). The plaque together with host immune response cause gingivitis (Perrone, 2009).

In gingivitis the gingiva becomes erythematous and swollen and lose their healthy sharp gingival margin. The gingiva may bleed spontaneously or on probing. As gingivitis progresses, the inflammation extends from the free gingival margin to the attached gingiva (Perry and Tutt, 2015). If left untreated, gingivitis can progress further on to the inflammation of other periodontal tissues. Occasionally, gingivitis does not progress to periodontitis - in this case it is considered that there is a symbiosis between the host tissues and the plaque biofilm, and this is not a threat to the oral tissues (Perry and Tutt, 2015).

1.2. Gingival hyperplasia

Aetiology of generalised gingival hyperplasia can be hereditary, caused by chronic inflammation, or a side effect of drugs (DeBowes 2010). Mikiewicz et al. (2019) also add accumulation of dental plaque to the list of causes of gingival hyperplasia. Hereditary gingival hyperplasia is seen at least in Boxers and Collies (DeBowes, 2010). The drugs causing hyperplastic gingiva are for example cyclosporine (Ullal et al. 2019), calcium-channel blockers and phenytoin (DeBowes, 2010). The mode of action of these drugs is stimulation of gingival fibroblasts which cause proliferation of gingival tissue both in dogs and cats (DeBowes, 2010). Localised gingival hyperplasia, however, can be caused by tooth resorption lesions commonly seen in cats as they age (DeBowes, 2010).

According to the study by Mikiewicz et al. (2019) gingival hyperplasia was the most common oral cavity lesion found in dogs. On histological examination, the gingival hyperplasia was mostly a lymphoplasmacytic inflammation, and it seems that both in dogs and cats the lesions are commonly due to inflammatory factors, but there is also a possibility that chronic irritation may contribute to the development of such lesions (Mikiewicz et al., 2019). Gingival hyperplasia was found to be more common in dogs than in cats (Mikiewicz et al., 2019). Juvenile hyperplastic gingivitis also occurs in dogs, but is much more prevalent in feline patients (Niemiec, 2013).

The characteristics of gingival hyperplasia in these abovementioned conditions (drug-induced, hereditary, chronic inflammation) are similar to juvenile hyperplastic gingivitis: bleeding, pseudopockets and erythema are commonly seen (DeBowes, 2010). A pseudopocket is defined by increased vertical probing depth caused by hyperplasia of the free gingiva, without periodontal attachment loss (Gorrel and Hale, 2012). DeBowes (2010) also points out that gingival margins lose their sharp edges and in severe cases the gingiva can cover the teeth completely.

1.3. Feline juvenile hyperplastic gingivitis

Besides the typical gingivitis seen in animals at any life stage, in young cats we can also come across a form of gingivitis known as feline juvenile hyperplastic gingivitis (FJHG). This form of gingivitis is confined to cats in puberty and is characterised by excess of inflamed gingival tissue, with pseudopockets of more than 1mm deep (Kääramees, 2018).

Niemiec (2013) claims that the condition is non-painful. However, Kääramees (2018) has noticed that when the cats have gone through the procedure and have been prescribed analgesia, the owners see change in the cats' behaviour, which suggests that there is some pain and/or discomfort related to the condition.

Mihaljevic (2017) points out that if the condition is not treated early, the junctional epithelium can be irreversibly destroyed, so that pathogens have an easy access to the periodontal gap, and this can quickly lead to juvenile periodontitis. The condition in which signs attributable to both juvenile hyperplastic gingivitis and juvenile periodontitis are present in the same patient, is

called feline juvenile gingivitis-periodontitis (Mihaljevic, 2017) or juvenile hyperplastic gingivitis/periodontitis (Perrone, 2016).

1.3.1. Classification by Williams and Aller

Feline juvenile hyperplastic gingivitis is often considered to belong under the wider umbrella of feline gingivostomatitis syndrome. Mihaljevic (2017) used the following classification in her study, created by Williams and Aller, which is the only classification of feline gingivostomatitis syndrome complex so far. The cats are grouped according to clinical signs in the classification (Mihaljevic, 2017).

Group 1 includes feline juvenile hyperplastic gingivitis "with highly inflamed and hyperplastic gingiva, often in incisor region, and in young cats during tooth changing period" (Mihaljevic, 2017).

Group 2 consists of "Juvenile progressive gingivitis-periodontitis like in group 1, with addition of rapidly progressing periodontitis, even in young cats who are changing teeth, and who often are affected by respiratory disease complex" (Mihaljevic, 2017).

Group 3 consists of "Adult progressive periodontitis that does not belong to the classic gingivostomatitis form" (Mihaljevic, 2017).

Group 4 involves "Adult chronic gingivostomatitis with significant inflammation in large part of the oral mucosa, especially caudal and buccal regions, and with involvement of the arcus palatoglossus" (Mihaljevic, 2017).

Finally, group 4 is further subdivided into group 4a and group 4b. Group 4a comprises of immunosuppressed cats with chronic or cyclic leukopenia in complete blood count, and group 4b consists of hyperreactive cats with leucocytosis and increased total protein due to hypergammaglobulinemia seen in complete blood count (Mihaljevic, 2017).

Mihaljevic (2017) notes that if treatment is not provided for cats in groups 1 and 2, this often leads to adult FCGS (feline chronic gingivostomatitis) as described in group 4. In addition, Reiter (2018) has suggests that juvenile hyperplastic gingivitis can be a factor for developing stomatitis in adulthood. According to Mihaljevic (2017) and Johnston (1998) feline juvenile

hyperplastic gingivitis, feline juvenile periodontitis and feline chronic gingivostomatitis share similar aetiology, and in some cats this is the progress from a less severe syndrome to a more severe syndrome in the gingivostomatitis complex syndrome.

1.3.2. Aetiology

The aetiology of feline juvenile hyperplastic gingivitis is unknown (Niemiec, 2014; Perrone, 2016). A hypothesis suggests an infectious factor to play a role in the development of feline juvenile hyperplastic gingivitis (Niemiec, 2014). Both FJHG and FCGS share the same type of inflammation - lymphocytes and plasma cells are the major white blood cells in the affected tissues in the oral cavity, with increased level of cytotoxic CD8+ T cells (Lee et al. 2020; Mihaljevic 2017). Increased number of CD8+ cells indicate a viral-immunological pathogenesis (Mihaljevic, 2017).

In Mihaljevic's (2017) retrospective study cats with gingivostomatitis syndrome, including those with feline juvenile hyperplastic gingivitis, were analysed and grouped into four categories described above. According to Mihaljevic (2017), the cats in her study often had either a history of feline respiratory disease complex or a confirmed viral infection. The viruses detected were feline immunodeficiency virus (FIV), calicivirus (FCV), herpesvirus (FHV) and feline leukemia virus (FeLV), in descending order of prevalence. Besides the viruses, also *Pasteurella multocida* has been detected in stomatitis cats (Mihaljevic, 2017). Mihaljevic (2017) suggests, that also allergenic stimuli may be a possible factor in the development of gingivostomatitis in cats.

1.3.3. Age

Feline juvenile hyperplastic gingivitis begins most commonly around the time of eruption of permanent teeth, which normally occurs at 4-7 months of age in the domestic cats (Muylle, 2018). The disease can develop soon after the permanent teeth have erupted (Niemiec, 2013), just before, or during the permanent tooth eruption (Williams and Aller, 1992). Therefore, the disease is considered to have a pubertal onset.

FJHG commonly begins under 9 months old (Perry and Tutt, 2015), more precisely at the age of 6 to 8 months (Bellows, 2010; Reiter 2018; Perrone, 2009). Mihaljevic (2017) describes that Maine Coons can show the symptoms earlier than other breeds, around the age of 7 months.

Niemiec (2010) writes that the disease seems to pass approximately by the age of two years. However, if aggressive treatment is not started, there is a high chance of progression to juvenile and/or adult periodontitis and early tooth loss as mentioned above.

1.3.4. Breed

Any breed can be affected (Bellows, 2010). A few literature sources (Perrone, 2009; Williams and Aller, 1992; Bellows, 2010) list Abyssinian and Persian as more commonly affected breeds, while Niemiec (2010) mentions that there seems to be a genetic predisposition in Maine Coon, Siamese and Somali breeds. In Mihaljevic's (2017) study Maine Coons were separated as an own subgroup in analysis of the disease, all belonging to group 2 with juvenile hyperplastic gingivitis and periodontitis in classification by Williams and Aller. This suggests that the disease may have a more severe form in Maine Coons and this should be kept in mind when diagnosing them with FJHG.

1.3.5. Clinical Signs

The owner may present the cat with complaints about difficulties chewing, bleeding during eating or playing, or pain during eating (Perrone, 2009; 2016, Kääramees, 2018). The owner may notice proliferative gingival tissue covering teeth (Perrone, 2009) or halitosis (Niemiec, 2013). Sometimes the condition might be found on a veterinary visit for spay or neuter as an incidental finding.

On an awake oral examination carried out by the veterinarian the most prominent sign is excess of erythematous, often friable gingival tissue and gingivitis. Halitosis may be noticed as well. On a sedated or anesthetized animal, bleeding from gingiva may be seen spontaneously or on probing (Niemiec, 2013). The junctional epithelium around the tooth neck is intact, meaning that there are only pseudopockets, not true attachment loss of a pathological periodontal pocket, and there often is an absence of obvious dental calculus (Williams and Aller, 1992).

Perry and Tutt (2015) suggest that deciduous maxillary fourth premolar teeth (teeth number 508 and 608 in the modified Triadan system) are indicator teeth for the condition. Hyperplastic tissue may cover all of the tooth crown on premolars and molars (Williams and Aller, 1992; Bellows, 2010). There can be also findings indicative of tooth resorption or periodontitis and for this reason the veterinarian needs to investigate the whole dentition carefully, including a whole mouth dental radiographic survey. According to Williams and Aller (1992) tooth resorption lesions accompanying this syndrome are possible already in puberty, although commonly otherwise considered rare in the young cat (Bellows, 2016).

When examining the oral cavity, the veterinarian needs to be careful to differentiate feline juvenile hyperplastic gingivitis from feline juvenile chronic gingivostomatitis (also called caudal stomatitis) and juvenile periodontitis, because all of these syndromes can be seen around the time of eruption of permanent teeth, but the cat can also have concurrent clinical signs related to all of them. In gingivostomatitis the inflammation extends from gingiva to mucosal and submucosal tissues whereas hyperplastic gingivitis is confined only to the gingiva. In juvenile onset periodontitis there is lack of gingival hyperplasia, but often already severe periodontal attachment loss. In feline chronic gingivostomatitis there often is no relation of the degree of the inflammation to the amount or occurrence of calculus deposits. (Johnston, 2012)

1.3.6. Diagnosis

The diagnosis is based on histology (Perry and Tutt, 2015). Without histology, the diagnosis is simply gingival enlargement because true hyperplastic diagnosis can be made only on a cellular level (Reiter, 2018). In hyperplastic gingivitis there is proliferation of gingival tissue, primarily cells of the connective tissue (DeBowes, 2010).

Histopathology of a tissue sample is taken during gingivectomy (Perrone, 2009) via incisional biopsy of the gingiva (Niemiec, 2013). The biopsy is taken in order to rule out other diagnoses for hyperplastic gingiva (Niemiec, 2014). Differential diagnoses to rule out would be neoplastic processes, although they are more common in older patients. Histopathologically FCGS has the same type of lymphoplasmacytic inflammation as FJHG (Williams and Aller, 1992).

Culture and sensitivity testing are generally not done as they are unrewarding (Niemiec, 2013). Niemiec (2013) suggests that culture and sensitivity testing can be considered in non-responsive cases, especially testing for *Bartonella* spp.

1.3.7. Management and treatment

Treatment principle of feline juvenile hyperplastic gingivitis is to cessate the disease and to remove the excessive gingival tissue covering the teeth crowns (Reiter, 2018). In every patient dental radiographs are taken to evaluate for evidence of periodontitis and tooth resorption lesions. Significantly diseased teeth need to be removed to decrease inflammation (Niemiec, 2013).

Feline juvenile hyperplastic gingivitis is treated with a procedure called gingivectomy together with scaling and polishing of the teeth (Perry and Tutt, 2015). Gingivectomy decreases the amount of inflammatory tissue and prevents plaque accumulation by removing the pseudopockets, meaning the normal depth of gingival sulcus (less than 1 mm in a cat) is restored (Niemiec, 2014). Pseudopockets offer an environment for the anaerobic plaque bacteria, and they are impossible to keep fully clean by oral homecare alone.

Niemiec (2014) suggests consistent dental cleaning performed under general anaesthesia every 6-9 months, Williams and Aller (1992) suggest even more frequent procedures, every 2-3 months. Even a small amount of plaque must be removed (Niemiec, 2013).

Consistent management and treatment, including both professional and homecare, are continued until around two years of age until the condition resolves (Williams and Aller, 1992; Perry and Tutt, 2015).

1.3.7.1. Gingivectomy

Gingivectomy is the removal of excess gingiva, which is done together with gingivoplasty. Gingivoplasty is the process of restoring the physiological gingival contours (Reiter and Southerden, 2018).

First, the excess gingival tissue of free gingival margin is removed with a scalpel blade. In order to do this, the gingival pocket is measured with periodontal probe, the desired level of gingiva is marked by creating bleeding points on external surface of gingiva, and the gingiva is excised slightly apical to the bleeding points in 45-degree angle to completely remove the pseudopockets (Reiter and Southerden, 2018). In FJHG cats, the excess gingival tissue is often extremely friable and creating a distinct line of bleeding points may be impossible due to widespread bleeding in itself. In this case the best estimate of the cut level has to be made using a periodontal probe, trying to perhaps err more on the side of caution and rely later on gingivoplasty for finer remodelling (K. Kääramees, personal communication, 9.5.2021).

In gingivectomy the excess gingival tissue is removed, and the normal gingival sulcus depth of maximum 1 mm is left (Williams and Aller, 1992). At least 2 mm of attached gingiva (the zone between mucogingival junction and free gingiva) needs to be left (Bellows, 2010). Reiter and Southerden (2018) advise to be careful in gingivectomy because cats often have less than 2 mm of attached gingiva.

Contouring the gingival margin and haemostasis are then achieved with a bullet-shaped 12-fluted bur or a diamond bur on a high-speed handpiece with water cooling (Reiter and Southerden, 2018). Alternatively, electrosurgical loops (Reiter and Southerden, 2018) or laser ablation (Bellows, 2010) can be used instead for the procedure. With non-careful use of electrocautery there is a risk of thermal injury to the tooth pulp or other tissues (Kääramees, 2018). After gingivoplasty, the teeth are scaled and polished.

According to Reiter and Southerden (2018), gingivectomy and gingivoplasty are contraindicated "in patients with less than 2 mm of attached gingiva and when horizontal or vertical bone loss extends beyond the mucogingival junction" – these signs would occur when there is advanced periodontitis – true attachment loss – in addition to gingival hyperplasia and would then indicate the necessity of extraction of the tooth involved.

1.3.7.2. Recombinant feline interferon omega therapy

Hennet et al. (2011) studied the efficacy of recombinant feline interferon omega (rFeIFN- ω) treatment in calicivirus-positive cats suffering from FCGS who were also refractory to tooth extractions. Hennet et al. (2011) saw significant improvement in the cats' condition treated with

interferon omega. The cats were administered 0,01 ml (0,1 MU) interferon omega daily via oromucosal route. During the 90-day-course of treatment, the cats demonstrated decreased pain scores and improvement in oral lesions (Hennet et al., 2011).

Mihaljevic (2017) also suggests long-term recombinant omega interferon treatment for inflammatory feline oral disease. In Mihaljevic's study (2017) cats received omega interferon both systemically and locally. Local application was given via submucosal injections, and daily oromucosal application at home by owners (Mihaljevic, 2017). Conjunctival route is an alternative for local oromucosal route, but there is a question whether conjunctival route would be as effective, as placing the drug on the inflamed tissues via oromucosal route (Mihaljevic, 2017). Omega interferon therapy seems to be efficient especially in cats with viral infection (Mihaljevic, 2017). However, Mihaljevic's study (2017) lacks higher level of evidence for the use of interferon omega therapy since interferon therapy was used for every cat in the study, and there was no control group.

Mihaljevic's (2017) suggestion for treatment of mild gingivostomatitis:

- 1 submucosal dosage of interferon omega with dose of 0,1-0,2 ml (1-2 MU)
- subcutaneous dosage of interferon omega with dose of 0,1-0,2 ml/kg, for cats with FIV, FeLV, or who are resistant to the therapy
- daily application of 2-3 drops interferon omega on oral mucosa by the owner
- dental procedure including plaque removal, gingivectomy, dental radiography and tooth extraction(s) when necessary
- supplementing therapy consisting of for example vitamins, oral hygiene gel and a special diet
- antibiotics for possible secondary bacterial infections

1.3.7.3. Oral homecare

Niemiec (2014) emphasizes that daily brushing is the gold standard of oral homecare. Owners can also be encouraged to use oral chlorhexidine rinse or gel (Niemiec, 2014), or oral zinc ascorbate gel (Niemiec 2013; Clarke, 2001) which reduce plaque. There are also available special commercial diets for dental health which the owner can add to the oral homecare routine (Niemiec, 2014). The most important method is brushing the teeth daily either with a

toothbrush, a cotton tip, or a gauze pad. Without brushing the teeth and gingival margins from plaque, the oral homecare will not be adequate.

1.3.8. Prognosis

As Perrone (2016) points out, the disease usually resolves around two years of age if regular dental cleaning has been performed together with strict oral homecare, regardless of whether gingivectomy has been performed. For those who will revert to normal gingival health, it takes months to years of treatment that has been started early and aggressively to prevent periodontal attachment loss occurring before the resolution of the disease (Bellows, 2010, Niemiec, 2014).

If left untreated, the condition often leads to more severe juvenile periodontal disease (Niemiec, 2013). Some patients will develop chronic oropharyngeal inflammation (Bellows, 2010).

1.4. Juvenile onset gingivitis in humans

Interestingly, humans have a similar condition to feline juvenile hyperplastic gingivitis, called puberty-associated gingival enlargement. The theory is that there is a temporary decrease in immune status during the puberty (Niemiec, 2014). It is also thought that pubertal gingivitis in humans may be associated with the level of steroid hormones (Tiainen et al., 1992). However, Tiainen et al. (1992) found that gingival bleeding during puberty was more associated with plaque accumulation rather than with the level of steroid hormones during different pubertal stages. Steroid hormones affect blood vessel permeability (Tiainen et al., 1992), production of inflammatory mediators, and growth and differentiation of fibroblasts and keratinocytes (Dholakia et al., 2016). These components together with dental plaque can cause gingival enlargement in humans.

The clinical signs include bleeding on brushing or on provocation, pink oedematous gingiva and the loss of sharp gingival margins (Dholakia et al., 2016). Like in cats, the pubertal gingivitis in humans usually disappears as the person matures (Niemiec, 2014).

The treatment in humans is similar to that in cats - gingivectomy of the excessive gingival tissue. On histological level para-keratinized stratified squamous epithelium, thick bundles of

collagen fibres and inflammatory infiltration were found in the excised gingiva (Dholakia et al., 2016).

2. AIMS OF THE STUDY

1. To characterize the clinical appearance of feline juvenile hyperplastic gingivitis.

2. To describe the management options and their effectiveness on an individual patient.

3. To offer knowledge of the disease scarcely described in scientific literature, in order for veterinarians to recognize the disease, and to be aware of treatment methods.

3. MATERIALS AND METHODS

3.1. Study population

Population of the study consists of 23 feline patients who were diagnosed with or treated for feline juvenile hyperplastic gingivitis at the Small animal clinic of Estonian University of Life Sciences (*Väikeloomakliinik*) during the period from November 2015 to March 2021. 22 of the cats were living in Estonia, one cat came to the clinic from Finland. The cats included in this study were ≤2 years old at the time of diagnosis, which is the age by when the disease should either cease or change into adult-form gingivitis-periodontitis or FCGS. The diagnosis of these patients was based on the signalment, history and clinical examination without histopathology. Ideally, a biopsy sample should be taken to confirm the diagnosis on a histopathological level, but due to the lack of owners' interest to incur further costs related to histopathology, none of the patients had a biopsy taken.

3.2. Collecting data

The data was collected from the clinic software (Provet Cloud) used by *Väikeloomakliinik* (VLK). All the above-mentioned patients' medical history available on the clinic software was reviewed. For collecting information about long-term response, the owners were contacted via a phone call in early April 2021. Of 23 owners, three could not be reached, and one owner whose cat visited the clinic 31.3.2021, was not given a phone call since the cat was just seen at the clinic. The owners were asked about the cat's general wellbeing and oral homecare, and they were also asked to assess the cat's current oral health. Some owners immediately started elaborating the oral condition and the postoperative progress, some owners had to be asked definite questions, e.g. is there gingival redness or is there halitosis. The longest follow-up period from the first appointment was 5 years and 4 months, and the shortest follow-up period was 3 months.

A summarizing table of the animals involved in the study can be found in Table 1. following the patient cases.

3.3. Treatment options used at Väikeloomakliinik

All the cats who were anesthetized for gingivectomy, received a COHAT (comprehensive oral health assessment and treatment). The COHAT included intraoral radiography of the whole mouth, charting to record the state of the dentition and oral cavity, removal of dental calculus and plaque, and polishing the teeth. The surgical treatment consisted of gingivectomy and gingivoplasty. If advanced periodontitis was present, also tooth extractions were performed.

Gingivectomy was performed with a scalpel blade on areas where the probing depth of gingiva exceeded over 1mm, to reduce the gingival pocket depth to 0,5-1mm. Gingivoplasty was performed to remove the inflamed tissue layer and to create a sharp gingival margin. Gingivoplasty was done with a high-speed diamond bur with water cooling.

All cats were anaesthetized according to an individual plan. For premedication, the cats received either dexmedetomidine, butorphanol and midazolam, or dexmedetomidine and butorphanol. Induction was performed with ketamine and midazolam and/or propofol, after which intubation (with lidocaine applied to the arytenoids priorly) and administration of isoflurane with oxygen for maintenance of anaesthesia followed. Local anaesthetic nerve blocks were performed in individual cases. Some cats received fentanyl-ketamine-lidocaine infusion, or ketamine boluses during the maintenance phase for additional analgesia and isoflurane-sparing effect.

All the cats who underwent a dental procedure, received a single dose of buprenorphine and a single dose of injectable meloxicam for analgesia postoperatively, with continuation of meloxicam orally once a day (SID) for a period of 5-7 days at home. Cats who were assessed by the treating veterinarian to have a very severe inflammation and/or beginning of signs of mucositis, were also put on an antibiotic therapy (cefovecin or amoxicillin/clavulanic acid). Three cats were diagnosed also with FCGS, of which two received feline recombinant omega interferon therapy.

The oral homecare was strongly suggested to consist of toothbrushing and the use of oral hygiene gels, both daily - either once or twice a day. The oral gels suggested for the patients contained either chlorhexidine, zinc ascorbate or lactoferrin B as the active ingredient. If the owner was not willing to brush the pet's teeth daily, or if the cat was not amendable to brushing,

then it was suggested to use at least two different oral hygiene products, such as the abovementioned oral gels, omega fatty acids, a veterinary dental diet and a xylitol/chlorhexidine water additive. All suggested oral homecare modalities were based on having at least some published information on clinical efficacy regarding the method or the active ingredient of the product. The suggested oral homecare products can be found in Appendix 1.

4. RESULTS

4.1. Patient cases

Cat 1

Patient description and history: Cat number 1 is a male neutered Maine Coon who was 7-month-old at the time of initial presentation. A referring veterinarian noticed signs suggestive of feline juvenile hyperplastic gingivitis when the cat was brought in for castration (December 2015).

Figure 1. The gingival situation at the time of castration. Photo: Kadri Kääramees

Findings in the oral cavity: The cat had hyperplastic gingivitis on both maxillary canines, maxillary left and right 2nd premolars, supernumerary left maxillary 2nd premolar, right maxillary 3rd premolar, left and right maxillary 4th premolars, and on mandibular 3rd premolars on both sides. Other findings were stage 1 mobility (horizontal movement of 0,2-0,5mm) of mandibular 1st and 2nd incisors on both left and right side.

Treatment: Gingivectomy and gingivoplasty were performed and a 7-day-course of antibiotic therapy (amoxicillin/clavulanic acid) was initiated. Analgesia was provided according to the standard protocol described previously (buprenorphine and meloxicam).

Response to the treatment and owner feedback: Approximately a year after the dental procedure (March 2017), it was noticed during a non-dental, emergency visit due to vague gastrointestinal signs that the cat had gingivitis on maxillary premolars. The owner also reported that the cat had had gingivitis also previously which was treated with antibiotics by a local veterinarian. The cat was prescribed a course of amoxicillin/clavulanic acid by the attending emergency veterinarian.

The long-term response is unknown since the owner could not be reached for feedback, but based on known history it is likely that this cat was at least a partial non-responder to the treatment and continued on to have oral inflammatory disease issues also later in life.

Cat 2

Patient description and history: Cat number 2 is a female spayed Domestic Shorthair who was 1,5-year-old at the time of initial presentation. She was brought to VLK due to gingival redness in December 2015. The owner had already been using oral chlorhexidine gel twice daily for two weeks.

Findings in the oral cavity: The cat had mild hyperplastic gingivitis especially on maxillary premolars and moderate amount of dental calculus.

Treatment: The owner received a thorough recommendation regarding the cat's oral homecare and its importance, and the cat was booked for an anaesthetic procedure. The owner cancelled the anaesthetic procedure later over the phone with no reason given.

Response to the treatment and owner feedback: There is no further history of the patient and the owner could not be reached via phone for feedback – long-term effects are unknown.

Cat 3

Patient description and history: Cat number 3 is a male neutered Maine Coon who was 7-month-old at the time of initial presentation. He was referred to VLK due to swollen gingiva observed by another veterinarian in January 2017. The owner reported that the cat had no problems with eating.

Findings in the oral cavity: There was hyperplastic gingivitis on right maxillary 1st molar, both maxillary 2nd and 4th premolars, left maxillary canine, left and right mandibular 1st molar, left and right mandibular 3rd premolar, and on both mandibular canines. On right mandibular 1st molar, very early stage 3 (the probe penetrates through the furcation) furcation exposure was detected, with soft tissue still filling the furcation. The maxillary 2nd premolars were bi-rooted on both sides. The amount of dental calculus was small.

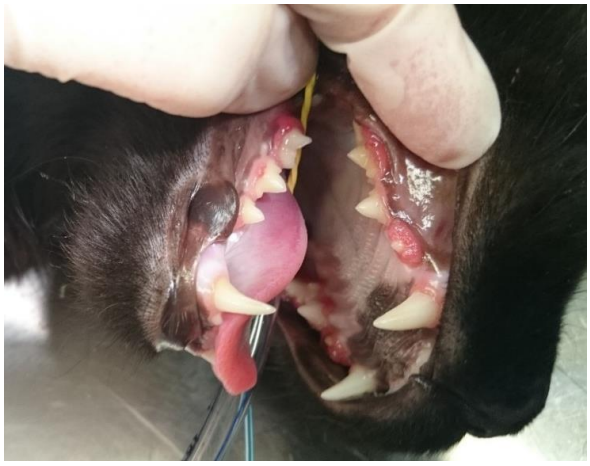

Figure 2. The gingival situation pre-op. Photo: Kadri Kääramees

Treatment: The cat's teeth were being brushed 1-2 times a day and oral chlorhexidine gel was applied twice a day until receiving gingivectomy and gingivoplasty. Analgesia consisted of a single dose of buprenorphine and a 5-8-day-course of meloxicam. An 11-day-course of antibiotic therapy (amoxicillin/clavulanic acid) was initiated.

Figure 3. The gingiva right after gingivectomy. Photo: Kadri Kääramees

Figure 4. The healed gingiva 1 week post-op. Photo: Kadri Kääramees

Response to the treatment and owner feedback: A month after the initial dental procedure there was a recurrence of hyperplasia on both maxillary 2nd premolars and on the distal aspect of left maxillary 4th premolar. On mandibular vestibular mucosa there was now a pyogranuloma caused by a traumatizing tip of right maxillary 4th premolar. The condition required another gingivectomy and gingivoplasty. The pyogranuloma was removed but it was decided not to perform odontoplasty (surgical contouring of the tooth surface) on the right 4th premolar of the maxilla at this time, as it seemed the malocclusion causing the pyogranuloma had already resolved and there would not be a need for odontoplasty. The alveolar bone loss on right mandibular 1st molar had significantly improved and the furcation could not be entered with the periodontal probe anymore. Oral homecare was continued.

When receiving feedback from the owner four years after the initial presentation, the oral cavity had remained in a good condition and the cat responded to the treatment well. The owner continues brushing teeth twice a week and feeds a dental diet.

Cat 4

Patient description and history: Cat number 4 is a female spayed Domestic Shorthair who was 11-month-old at the time of initial presentation. She was brought to the clinic for a health check in May 2017 and she was diagnosed with feline hyperplastic gingivitis based on the signalment, history and clinical signs.

Findings in the oral cavity: On awake examination there was noted hyperplastic gingivitis in the oral cavity.

Treatment: The owner refused the treatment under anaesthesia. The cat received oral chlorhexidine gel for some time.

Response to the treatment and owner feedback: When receiving the long-term feedback from the owner four years later, the owner said the use of oral chlorhexidine gel had reduced the gingival redness. The owner assessed the cat's oral health to be good and that the cat responded well to oral homecare alone. Presently the cat receives an unspecified feed additive with an oral health supporting function.

Cat 5

Patient description and history: Cat number 5 is a male neutered Maine Coon who was 9-month-old at the time of initial presentation. He had received a gingivectomy procedure for suspected FJHG related gingival hyperplasia noted by the referring veterinarian during the castration (phone consultation at the time with Dr K. Kääramees) two months ago in another clinic, and was now referred to VLK due to recurrence of the gingival overgrowth for another gingivectomy, and a full COHAT complete with dental radiography (September 2017). The owner was using oral chlorhexidine gel intermittently. The cat was already found to be positive for calicivirus by the referring veterinarian.

Findings in the oral cavity: The cat had hyperplastic gingivitis on all right maxillary premolars and on left maxillary 4th premolar. There was gingival recession (1mm) on left mandibular 1st molar. The cat had small amount of dental calculus.

Treatment: The cat received gingivectomy and gingivoplasty, and analgesia was provided according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: There's no further history and the owner was not able to be reached, thus the response is unknown.

Cat 6

Patient description and history: Cat number 6 is a female spayed Maine Coon who was 8-month-old at the time of initial presentation. She was referred to VLK for a treatment of feline juvenile hyperplastic gingivitis in November 2017. Her only problem was that she had started to eat more carefully.

Findings in the oral cavity: The findings were hyperplastic gingivitis involving left and right maxillary 4th premolars, left and right mandibular 1st incisors, right mandibular 3rd and 4th premolar, and all four 1st molars. There was only small amount of dental calculus.

Treatment: Gingivectomy and gingivoplasty were done at the clinic and analgesia was provided according to the standard protocol (buprenorphine and meloxicam). Toothbrushing was started at home.

Response to the treatment and owner feedback: Initially, she responded to the treatment well, but two months later, mild hyperplasia had recurred on right maxillary canine, right maxillary 4th premolar and right maxillary 1st molar. She then received another gingivectomy and gingivoplasty under anaesthesia. During the anaesthesia it was noticed that the oral caudal mucosa was slightly erythematous. The owner continued oral homecare with regular toothbrushing and oral chlorhexidine gel, which seemed to help keep the cat's gingiva and teeth in a rather good condition. Mild local hyperplasia on right maxillary 4th premolar and slightly erythematous lymphoid follicles bilaterally on the caudal mucosa were still noted a month after the second procedure.

When receiving the feedback for long-term response, 2,5 years since the initial diagnosis, it was found that the cat is doing very well, and the oral cavity is in a good condition. The current oral homecare consists of the daily use of oral chlorhexidine gel, toothbrushing 2-3 times a week, and a veterinary dental dry food.

Cat 7

Patient description and history: Cat number 7 is a male Maine Coon who was 7-month-old at the time of initial presentation. When arriving to VLK (March 2018), he was already receiving meloxicam prescribed by a referring veterinarian. The owner reported that while the

cat had been on meloxicam, the appetite had markedly improved, although previously the owner had not understood that there was pain in the mouth. Also oral chlorhexidine gel was already being applied twice a day.

Findings in the oral cavity: The findings were severe hyperplastic gingivitis on all molars and premolars, and on both maxillary canines. Probing depth was pathological only in the pseudopockets. Mild alveolar bone loss on right mandibular 4th and 3rd premolar and on left mandibular 1st molar was discovered.

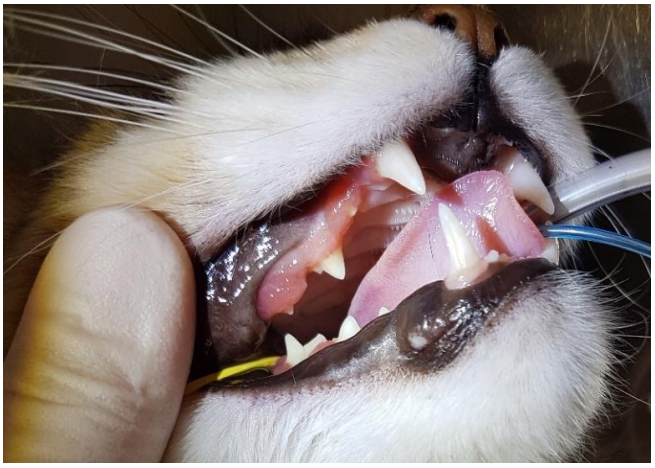

Figure 5. The hyperplastic gingiva pre-op. Photo: Kadri Kääramees

Treatment: The treatment consisted of gingivectomy and gingivoplasty at the clinic, with analgesia according to the standard protocol (buprenorphine and meloxicam), and oral homecare consisted of daily toothbrushing and oral chlorhexidine gel twice a day.

Figure 6. The gingiva right after gingivectomy and gingivoplasty. Photo: Kadri Kääramees

Response to the treatment and owner feedback: The cat was brought to a re-check appointment three weeks later. There was some erythema on the gingival margin, but no hyperplasia nor bleeding. The owner was advised to add into oral homecare dietary omega fatty acids and lactoferrin B containing oral gel.

Currently, three years after the initial presentation, the cat's oral health is excellent. The owner had continued brushing teeth twice daily for 6 months postoperatively, but currently there is no oral homecare being performed.

Cat 8

Patient description and history: Cat number 8 is a male neutered Maine Coon who was 10-month-old at the time of initial presentation. He was referred to VLK for a gingivectomy in March 2018. The referring veterinarian had diagnosed hyperplastic gingivitis two weeks earlier, and had administered cefovecin and initiated a non-steroidal anti-inflammatory treatment due to the severe inflammation and at least moderate pain noted in the oral cavity. The owner had tried to apply oral chlorhexidine gel, but the cat didn't tolerate it.

Findings in the oral cavity: Severe generalized hyperplastic gingivitis was discovered on the whole maxillary dental arch. On the left side of the mandible, 3rd incisor, canine, 3rd and 4th premolar, and 1st molar were involved. The least involved quadrant was the right side of the mandible where affected were canine, 3rd premolar and 1st molar. There was only little dental calculus. Mild alveolar bone loss (5-10%) on both mandibular 1st molars was noted as well.

Figure 7. The oral cavity pre-op. Photo: Kadri Kääramees

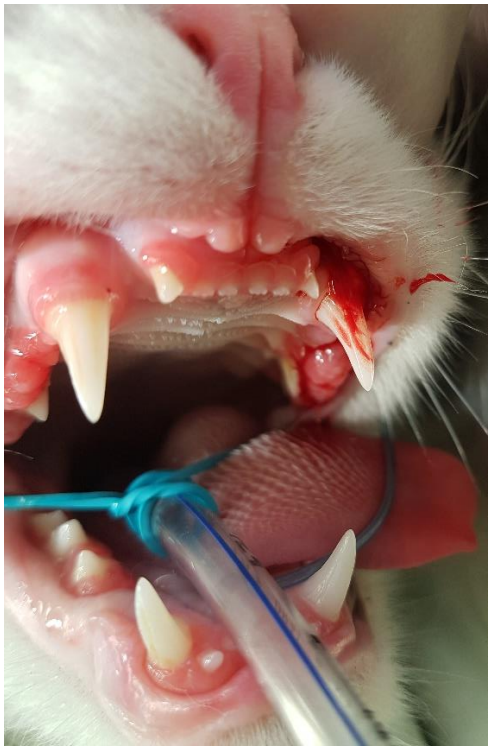

Figure 8. The oral cavity pre-op. Photo: Kadri Kääramees

Treatment: The cat received gingivectomy and gingivoplasty, and the antibiotic treatment was continued. Analgesia was carried out according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: The cat did not respond to the treatment. The owner neglected to continue with any subsequent procedures (due to the distance from the clinic and difficulties in transporting the cat). Two weeks after the anaesthetic procedure the cat already had a recurrence of gingival hyperplasia noted by the referring veterinarian.

Presently, three years later, the cat is still suffering from hyperplastic gingivitis and halitosis. He eats soft food only and chews with one side. He does not receive any oral homecare.

Cat 9

Patient description and history: Cat number 9 is a male neutered Maine Coon who was 8-month-old at the time of initial presentation. He was brought to the clinic in March 2018 due to owner's observation that the cat was eating dry food slower than before. Oral chlorhexidine gel was already being applied.

Findings in the oral cavity: There was severe generalized hyperplastic gingivitis on the whole maxillary dental arch. On the mandibular dental arch, the involved teeth were all left incisors, right 1st and 2nd incisor, supernumerary right 2nd premolar, left and right 3rd premolars, and both 1st molars. The cat had an unerupted right mandibular 3rd incisor.

Figure 9. The hyperplastic gingiva pre-op. Photo: Kadri Kääramees

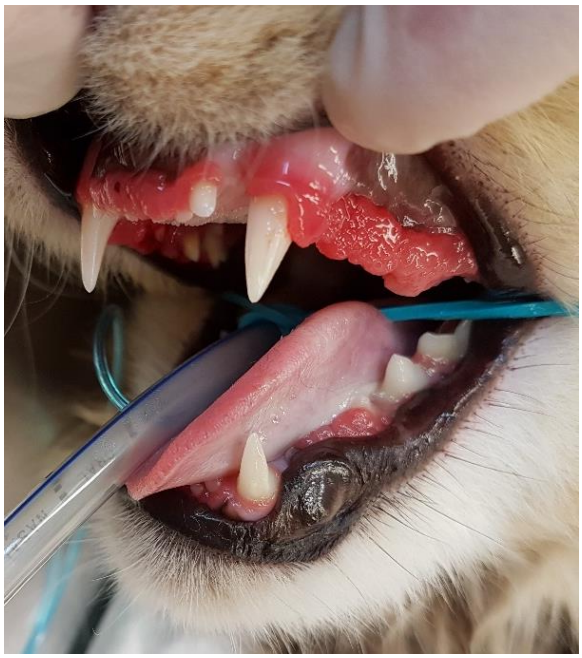

Figure 10. The hyperplastic gingiva pre-op. Photo: Kadri Kääramees

Treatment: The cat received gingivectomy and gingivoplasty to treat the hyperplastic gingiva, and operculectomy (surgical removal of gingival flap covering a tooth) of the right mandibular unerupted 3rd incisor. Analgesia was carried out according to the standard protocol (buprenorphine and meloxicam). The cat was prescribed a 5-day-course of antibiotic therapy (amoxicillin/clavulanic acid), and the owner started to brush the teeth once a day as oral homecare.

Figure 11. The gingiva right after gingivectomy and gingivoplasty. Photo: Kadri Kääramees

Figure 12. The gingiva right after gingivectomy and gingivoplasty. Photo: Kadri Kääramees

Response to the treatment and owner feedback: The owner reported that currently, 3 years after the initial presentation, there are no pathologies notable in the oral cavity anymore and response to the treatment was good. The owner was brushing teeth daily for 7-8 months following the procedure, and currently is brushing the teeth 2-3 times a week.

Cat 10

Patient description and history: Cat number 10 is a male neutered Domestic Shorthair who was 1-year-old at the time of initial presentation. The owner brought him in for an oral health check (October 2018). The owner had noticed redness of the gingiva two months prior to the visit and described the teeth to have stripes on them. The cat had also been seen rubbing his teeth against corners and objects. At that time, he was diagnosed with juvenile gingivitis, because he had gingivitis and halitosis, but no hyperplasia. The owner was encouraged to start brushing the cat's teeth and using oral chlorhexidine gel twice daily. The oral homecare was successful, and the gingivitis began to recede in those parts of the dental arch which the cat allowed to be brushed. He didn't tolerate brushing the incisors, thus the gingivitis continued to exist there. The cat's oral health was being monitored over several re-check visits. In March 2019 gingival hyperplasia had developed around the incisors and he was diagnosed with feline juvenile hyperplastic gingivitis.

Findings in the oral cavity: The cat had hyperplastic gingivitis and pain on the area of incisors. There was also gingival recession on both maxillary 3rd incisors, and stage 1 mobility on all 3rd incisors. The gingiva of both mandibular 1st molars was locally erythematous.

Treatment: All incisors were extracted and the excess gingival tissue was removed with gingivectomy. Daily toothbrushing was continued. Analgesia was provided according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: In postoperative control, there was still mild erythema on the gingiva around incisors and local gingival erythema on left mandibular 1st molar, but no hyperplasia. Four months after the dental procedure, he developed periodontitis and moderate gingivitis with small amount of dental calculus. Mobility of right maxillary 1st molar, local gingival recession (2mm) on right mandibular 1st molar, and alveolar bone loss (30%) on left maxillary 4th premolar were noted. He received another COHAT during which right maxillary 1st molar was extracted due to periodontitis. After this the oral health started to improve.

Two years later (April 2021), the owner assesses the cat's oral condition as healthy. The owner is still providing ideal oral homecare with daily use of oral chlorhexidine gel and toothbrushing.

Cat 11

Patient description and history: Cat number 11 is a male neutered longhaired Scottish Straight who was 13-month-old at the time of initial presentation. The owner was recommended to turn to VLK for a dental procedure due to gingival erythema (November 2018).

Findings in the oral cavity: The cat had erythematous hyperplastic gingivitis on right and left maxillary 4th premolar, left maxillary 3rd premolar, right mandibular 3rd premolar, and on left mandibular 3rd premolar, 4th premolar and 1st molar.

Treatment: Gingivectomy and gingivoplasty were performed as treatment and analgesia was carried out according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: Three months following the dental procedure, the gingiva had started to become erythematous again, but there was no hyperplasia nor dental calculus. The erythema decreased somewhat with time. The owner was recommended to start using oral chlorhexidine gel twice daily and to try to brush the teeth.

Two years later (April 2021), the owner assesses the oral cavity as healthy, and there are no problems reported with the cat's health – the cat responded well to the treatment. The cat does not receive any oral homecare presently.

Cat 12

Patient description and history: Cat number 12 is a female spayed Domestic Shorthair who was 1,5-year-old at the time of initial presentation. According to the owner, the cat had been having red gingival margins since 5 months old. There was no improvement with the use of oral chlorhexidine gel, the situation had rather become worse over the time. The owner had observed that the cat was dropping food around the food bowl more than the owner's other cat. The appetite and general wellbeing were assessed to be good by the owner. She was brought to VLK in November 2018.

Findings in the oral cavity: Hyperplastic gingivitis on incisors and on both maxillary 2nd premolars. Small amount of dental calculus was noted. The cat had stage 1 mobility on left maxillary 2nd incisor and right maxillary 2nd premolar, and stage 2 mobility (horizontal movement of 0,5-1,0mm) on both mandibular 1st incisors.

Treatment: The cat received gingivectomy and gingivoplasty as well as extraction of right maxillary 2nd premolar, left maxillary 2nd incisor, and both mandibular 1st incisors. Pain was managed according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: The cat responded well to treatment and is doing well currently, three years since the initial presentation. The owner sometimes brushes her teeth with pet toothpaste and feeds a dental diet.

Cat 13

Patient description and history: Cat number 13 is a female Maine Coon who was 5-month-old at the time of initial presentation. She was seen at VLK due to swollen gingiva in January 2019.

Findings in the oral cavity: The cat had hyperplastic gingivitis involving both maxillary canines, all maxillary and mandibular premolars and molars, and supernumerary left and right mandibular 2nd premolars. She had also moderate dental calculus, and stage 1 furcation involvement (the periodontal probe enters <50% under the crown) of left maxillary 4th premolar.

Figure 13. The gingiva pre-op. Photo: Kadri Kääramees

Treatment: Gingivectomy and gingivoplasty were performed. Antibiotic treatment (cefovecin) was administered and analgesia was done according to the standard protocol (buprenorphine and meloxicam). Oral hygiene gel was applied twice daily postoperatively.

Figure 14. The gingiva 2 weeks after the first dental procedure. Photo: Kadri Kääramees

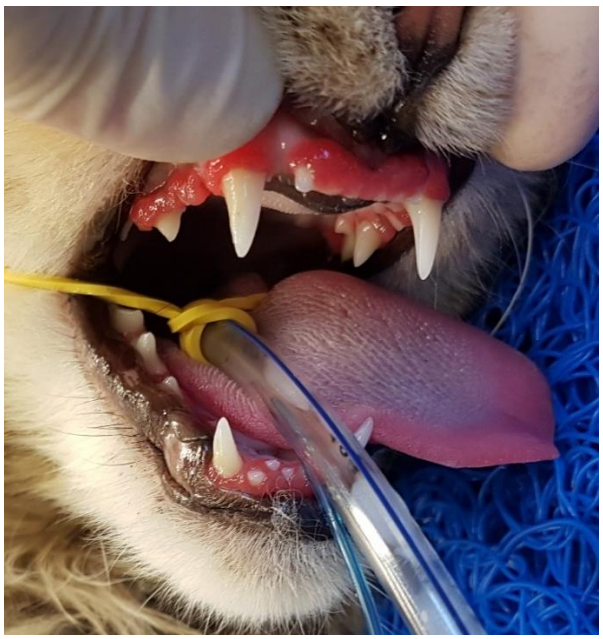

Figure 15. The gingiva 3 months after the first dental procedure. Photo: Kadri Kääramees

Response to the treatment and owner feedback: Gingival swelling, erythema, dental calculus and halitosis had recurred within two months since the operation. The next month also hyperplasia recurred on all four quadrants, regardless of improved oral homecare (additional toothbrushing). She required another gingivectomy three months after the initial gingivectomy. During the second dental procedure, alveolar bone loss on both mandibular 1st molars was noted. Gingivectomy was performed on the whole upper and lower dental arch and cefovecin was administered.

Two gingivectomies were enough, and currently (2 years after the initial presentation) the cat is doing well. Since the cat still has periodical gingival erythema, the response to treatment is assessed as good to moderate. The owner keeps brushing the teeth once a week.

Cat 14

Patient description and history: Cat number 14 is a female spayed Maine Coon who was 9-month-old at the time of initial presentation. The owner reported halitosis and gingival hyperplasia in April 2019. Oral chlorhexidine gel was already being applied on the gingiva.

Findings in the oral cavity: The cat had hyperplastic gingivitis on both maxillary 3rd incisors, both maxillary 2nd and 4th premolars, and all four canines, 3rd premolars and 1st molars. She had minimal dental calculus and bi-rooted maxillary 2nd premolars.

Treatment: Gingivectomy and gingivoplasty were performed, and analgesia was provided according to the standard protocol (buprenorphine and meloxicam)

Response to the treatment and owner feedback: Unknown – the cat had died due to FIP (feline infectious peritonitis) prior to receiving the owner's feedback.

Cat 15

Patient description and history: Cat number 15 is a female spayed Maine Coon who was 9-month-old at the time of initial presentation when she was diagnosed with juvenile gingivitis as an incidental finding during a clinical examination (September 2019). She also had conjunctivitis, which was suspected to be either due to feline herpesvirus or *Chlamydia felis* infection. A COHAT appointment was booked for the cat for two weeks later.

Findings in the oral cavity: Hyperplastic gingivitis was noted on both maxillary 3rd incisors, both maxillary 2nd and 4th premolars, both mandibular 3rd premolars, left mandibular 4th premolar, and both mandibular 1st molars.

Treatment: Gingivectomy and gingivoplasty were performed. Pain relief was done according to the standard protocol (buprenorphine and meloxicam). Oral homecare consisted of application of oral chlorhexidine gel.

Response to the treatment and owner feedback: Six months after the dental procedure the owner noticed that the application of oral chlorhexidine gel seemed to be painful for the cat. Toothbrushing had not been tried. The owner had not observed any changes in eating. The cat had a recurrence of hyperplastic gingivitis on incisors and on left maxillary 2nd premolar, elsewhere general gingivitis. Gingivectomy was performed once again (May 2020). The oral cavity stayed without pathologies for at least the next five months.

In 2021 the long-term response was assessed to be moderate. The owner reported that it seems the cat has started to have gingivitis again. She also has repeated periods of discomfort during eating, which pass when daily oral chlorhexidine gel and toothbrushing with pet toothpaste are started again after a period of no oral homecare.

Cat 16

Patient description and history: Cat number 16 is a female Maine Coon who was 8-month-old at the time of initial presentation. The owner brought her to VLK in October 2019 after noticing erythematous gingiva and the cat gnashing her teeth sometimes.

Findings in the oral cavity: Hyperplastic gingivitis was seen especially on maxillary premolars.

Treatment: The owner initially refused treatment under anaesthesia but took the cat for a COHAT at another clinic later.

Response to the treatment and owner feedback: The cat's oral situation did not resolve, and she still has hyperplastic gingivitis. The owner is brushing her teeth 2-3 times a week with pet toothpaste.

Cat 17

Patient description and history: Cat number 17 is a male neutered Maine Coon who was 1-year-old at the time of initial presentation. He was brought to VLK for a health check due to gingivitis in October 2019. The owner was brushing the cat's teeth already.

Findings in the oral cavity: The cat had hyperplastic gingivitis on both maxillary 4th premolars and a local mucosal pyogranuloma due to a caudal malocclusion (left maxillary 4th premolar tip traumatizing the mandibular vestibular mucosa at the level of mandibular 1st molar). The cat also had a mild non-traumatic and functional mandibular mesiocclusion (mandibular protrusion beyond the maxilla).

Treatment: The cat received gingivectomy and gingivoplasty of hyperplastic gingiva, odontoplasty of left maxillary 4th premolar, and removal of the traumatic pyogranuloma. Analgesia was provided according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: 1,5 years later, the owner describes that the cat is doing and eating well, and that the cat's oral situation is good. Some gingival erythema is still apparent, so the response is good to moderate. The teeth are still being brushed intermittently with pet toothpaste and he also gets dental dry food as a part of the whole diet.

Cat 18

Patient description and history: Cat number 18 is a male neutered Don Sphynx who was 1-year-old at the time of initial presentation. He was referred to VLK for a stomatological and an ophthalmological examination due to ocular discharge and inflammatory gingiva in December 2019. The owner reported the cat to be active and to have a good appetite.

Findings in the oral cavity: Hyperplastic gingivitis was noted on both maxillary and mandibular left and right 3rd and 4th premolars. Other findings were gingival recession on left mandibular 1st molar (4mm) and both maxillary canines (1mm), alveolar bone loss (40% of the height of the tooth roots) on both mandibular 1st molars, and enamel discolouration.

Treatment: The owner started to brush the cat's teeth and apply oral chlorhexidine gel twice a day until dental procedure. The cat was also prescribed a 10-day-course of meloxicam pre-

operation. The cat received gingivectomy and gingivoplasty, and the daily oral homecare was continued, as well as a short course of postoperative analgesia according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: A month after the procedure the gingiva were still slightly erythematous, but no hyperplasia nor swelling.

A year after the operation, the owner reports that the gingiva is still erythematous, but no hyperplasia - the response is good to moderate. The owner had decided to discontinue oral homecare.

Cat 19

Patient description and history: Cat number 19 is a male neutered Domestic Shorthair who was 1,5-year-old at the time of initial presentation. The owner reported halitosis and swollen gingiva in January 2020. The cat was eating normally. At that time during the clinical examination he was diagnosed with feline juvenile gingivitis. A month later it had progressed to feline juvenile hyperplastic gingivitis.

Findings in the oral cavity: Initially, generalized erythematous gingiva on all quadrants. A month later also gingival hyperplasia and mobility of both maxillary 3rd incisors.

Treatment: The cat received gingivectomy and extraction of both maxillary 3rd incisors. Analgesia was carried out according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: One procedure was enough to treat the oral situation. Currently, a year later, the owner reports that the oral cavity is still free of problems.

Cat 20

Patient description and history: Cat number 20 is a male neutered Domestic Longhair who was 1-year-old at the time of initial presentation. He was brought for a treatment of feline juvenile hyperplastic gingivitis in February 2020. He had been diagnosed with juvenile gingivitis a month prior at the referring clinic.

Findings in the oral cavity: Hyperplastic gingivitis involving both maxillary 2nd and 3rd premolars, right maxillary 4th premolar, and right mandibular 1st molar. The cat had moderate dental calculus. Right mandibular 1st incisor had a root fracture, gingival recession of 2mm and stage 3 mobility (>1,0mm of horizontal movement, or any vertical movement), left mandibular 1st incisor had stage 1 mobility. Attachment loss was noted also on left maxillary 3rd premolar and right mandibular 1st molar.

Treatment: Gingivectomy, gingivoplasty, and extraction of both mandibular 1st incisors were performed. Analgesia was carried out according to the standard protocol (buprenorphine and meloxicam), and the cat received also antibiotic therapy (cefovecin).

Response to the treatment and owner feedback: The cat received several more gingivectomies with three-month-intervals at another clinic and one more tooth had to be extracted.

The owner reports that currently, a year since the initial procedure, the cat has had a good oral situation for six months. The owner is using oral chlorhexidine gel once a day and a chlorhexidine and xylitol containing water additive. The cat is being fed dental dry food and raw food in order to help keep the teeth clean.

Cat 21

Patient description and history: Cat number 21 is a female spayed Maine Coon who was 11-month-old at the time of initial presentation. She was referred to VLK due to oral pain and changes in eating (July 2020). The owner had been trying to apply oral hygiene gel, but it was too painful for the cat. The cat was preferring dry food over wet food. She had also lost weight and the fur quality had decreased.

Findings in the oral cavity: Opening the mouth was painful, there was visible caudal mucositis and the caudal gingiva was bleeding. There was gingivitis on the whole dental arch of the maxilla and the mandible, and mild hyperplasia on both maxillary 2nd premolars and left 4th premolar, as well as on both mandibular 3rd premolars. A supernumerary 2nd premolar on the right maxilla was discovered. Both mandibular 1st molars had alveolar bone loss, stage 2

furcation involvement (the periodontal probe enters >50% under the crown but not through), and gingival recession (3mm). According to the clinical signs, history and age at onset, the cat was diagnosed with both feline juvenile hyperplastic gingivitis and juvenile gingivostomatitis.

Treatment: The cat received gingivectomy and gingivoplasty, and extraction of both mandibular 1st molars. Analgesia was carried out according to the standard protocol (buprenorphine and meloxicam). Additional medical therapy consisted of antibiotic (cefovecin) and interferon therapy. The 100-day long feline recombinant omega interferon therapy was applied via transmucosal route with a dosage of 1ml SID.

Response to the treatment and owner feedback: Two weeks post-operation the owner reported the cat was feeling well and eating better than before. The cat would have needed further treatment for oral disease, but the owner was not capable of providing necessary medical care for the cat and she was re-homed approximately 2 months post-operation. The long-term response is unknown, but presumably no response based on the minimal postoperative information.

Cat 22

Patient description and history: Cat number 22 is a male neutered Domestic Shorthair who was 1,5-year-old at the time of initial presentation. He was brought to VLK for a dental check in July 2020. The owner described that the cat had not been eating as well as usual for 2-3 months. The owner was feeding different types of soft food straight from the hand, the mouth was painful, and the cat had lost weight. The owner had tried to apply oral chlorhexidine gel without success.

Findings in the oral cavity: The cat had generalized hyperplastic gingivitis, periodontitis and mucositis. Some teeth were fully covered by swollen gingiva and the gingiva were bleeding slightly. He was diagnosed with both feline juvenile hyperplastic gingivitis and feline juvenile gingivostomatitis.

Treatment: The cat received an injectable antibiotic therapy (cefovecin) twice, and meloxicam before coming for the dental procedure. He had started to be more active and have a good appetite during the medications. Under anaesthesia, all premolars and molars as well as all

mandibular incisors were extracted, and the excess gingival tissue was removed with gingivectomy. He received three more doses of cefovecin, and analgesia was continued postoperatively according to the standard protocol (buprenorphine and meloxicam).

Response to the treatment and owner feedback: After extractions the cat had started to eat from the food bowl on his own, but he was scared to eat where the food bowl had been before the treatment and had associated it with pain. Two weeks after the operation the gingiva was still mildly erythematous and inflamed. No oral homecare was provided and 2 months post-operation there was still gingivitis and caudal mucositis. A 100-day-long feline recombinant omega interferon treatment was initiated with a dosage of 1ml SID transmucosally. Long-term recommendation was to remove the remaining teeth.

Presently, 9 months after the initial presentation, the oral situation is stable but not very good. The cat has occasional oral pain episodes and signs of FCGS. The interferon therapy had some effect but didn't completely resolve the disease, thus, the cat is classified as non-responder.

Cat 23

Patient description and history: Cat number 23 is a female spayed Maine Coon who was 1,5-year-old at the time of initial presentation. The cat had changed owners priorly and the new owner had noticed heavy drooling. She was referred to VLK in December 2020 for a dental procedure. She had been diagnosed with feline juvenile hyperplastic gingivitis at the referring clinic the previous month.

Findings in the oral cavity: There was moderate dental calculus and sublingual and caudal mucosa were inflamed. The cat had hyperplastic gingivitis on the whole maxillary and mandibular dental arch apart from both maxillary 1st molars. On canines there was alveolar bone remodelling and mild buccal expansion. Maxillary supernumerary bi-rooted 3rd premolars were discovered. There was stage 1 furcation involvement on all left maxillary and mandibular premolars, on right mandibular 3rd premolar, and on left mandibular 1st molar. The cat had also tooth resorption (type 1; inflammatory) on right mandibular 2nd incisor and inflamed tooth fragments of several incisors. She was diagnosed with both feline juvenile hyperplastic gingivitis and juvenile gingivostomatitis.

Figure 16. The inflamed gingiva before the operation. Photo: Kadri Kääramees

Figure 17. The inflamed gingiva before the operation. Photo: Kadri Kääramees

Figure 18. The inflamed gingiva and sublingual mucositis before the operation. Photo: Kadri Kääramees

Treatment: The cat received gingivectomy, gingivoplasty, and extraction of left and right mandibular 1st and 2nd incisors as well as left maxillary 1st incisor. Pain relief was provided according to the standard protocol (buprenorphine and meloxicam), and antibiotic therapy (cefovecin) was initiated.

Response to the treatment and owner feedback: 3 months post-operation (March 2021) the cat was eating dry food well, was active and playful and had gained weight. Regardless, the cat did not respond to the treatment and she has a recurrence of hyperplasia and erythema of the gingiva and mucosa.

Table 1. Physical data, clinical presentation and response to the treatment

Cat number	Breed	Sex	Age at diagnosis (months)	Owner's initial complaint	Other pathologies in oral cavity	Response to treatment
1	MCO	male	7,5	none	a supernumerary tooth, periodontitis	unknown
2	DSH	female	20,5	gingival redness	none	unknown
3	MCO	male	7,5	unknown	bi-rooted 2nd premolars, periodontitis, pyogranuloma	good
4	DSH	female	11	unknown	none	good
5	MCO	male	9,5	unknown	gingival recession	unknown
6	MCO	female	8,5	eating more carefully	caudal mucositis	good
7	MCO	male	7	owner noticed a positive change in appetite while the cat was on meloxicam	periodontitis	good
8	MCO	male	10	unknown	periodontitis	no response
9	MCO	male	8,5	eating dry food slower	supernumerary tooth, unerupted tooth	good

10	DSH	male	18,5	gingival redness, rubbing teeth against objects, striped teeth	gingival recession, periodontitis	good
11	SFL	male	13	unknown	none	good
12	DSH	female	19,5	drops food around food bowl more than the family's other cat, gingival redness, worsening situation of the gingiva regardless of using oral chlorhexidine gel	periodontitis	good
13	MCO	female	5	halitosis, gingival growth	supernumerary teeth, periodontitis	good to moderate
14	MCO	female	9,5	halitosis, no resolution regardless of using oral chlorhexidine gel	bi-rooted 2nd premolars	unknown
15	MCO	female	9,5	none	none	moderate
16	MCO	female	8	gingival redness, sometimes gnashing one's teeth	unknown	no response
17	MCO	male	17	none	malocclusion, pyogranuloma	good to moderate
18	DSP	male	15,5	none	enamel discolouration, gingival recession, periodontitis	good to moderate
19	DSH	male	18	halitosis, gingival redness and swelling	periodontitis	good
20	DLH	male	16,5	halitosis	periodontitis, fractured tooth root, gingival recession	good
21	MCO	female	11,5	oral pain, weight loss, decreased fur coat quality	supernumerary tooth, mucositis, periodontitis, gingival recession	unknown

22	DSH	male	18,5	change in eating, owner feeds soft foods straight from the hand, oral pain, weight loss	periodontitis, mucositis	no response
23	MCO	female	18,5	heavy drooling	mucositis, supernumerary bi-rooted teeth, tooth resorption, periodontitis, tooth root fractures	no response

DSH – Domestic Shorthair; DLH – Domestic Longhair; DSP – Don Sphynx; MCO – Maine Coon; SFL – Longhaired Scottish Straight

The response to the treatment was graded according to the clinical signs at the time of receiving owner feedback in the following way:

- good – no oral pathological changes reported by owner and initial presentation problems seem to have been completely resolved, resolution of oral disease
- good to moderate – slight or intermittent signs of mild oral disease reported (e.g. some gingival redness), with definite improvement compared to the initial presentation
- moderate – intermittently occurring mild to moderate signs of oral disease, less severe than at the initial presentation, reported by owners with a view of oral situation possibly worsening recently after a more stable period
- no response – progression of oral disease either involving also gingival hyperplasia and/or signs attributable to other forms of oral disease reported by owners

4.2. Clinical characteristics of the disease

4.2.1 Sex and age

Slightly more males (57%) than females (43%) were encountered in the study. The youngest cat at the time of diagnosis was 5 months old and the oldest was 20,5 months old. All cats' ages can be found in Figure 19. below. The median age at the time of diagnosis was 11 months (lower quartile 8,5 months; upper quartile 18 months). The median age at the time of diagnosis for females was 10 months, for males 13 months.

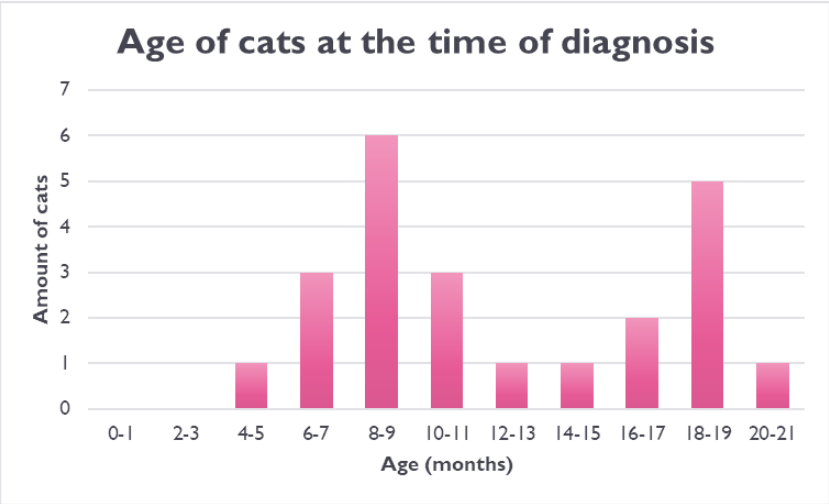

Figure 19. Age at the time of diagnosis

4.2.2. Breeds

The study suggests there is a strong predilection for the Maine Coon with 61% of the affected cats. Following with 30% of Domestic Short- or Longhair cats, and 8% representing the two remaining breeds of which both there was only one cat (one Don Sphynx and one Scottish Straight). The proportion of affected cat breeds can be seen in Figure 20. below. The median age at the time of diagnosis for the Maine Coon was 9 months and for the Domestic Short- or Longhair 18,5 months. The Don Sphynx was diagnosed at the age of 15,5 months and the Scottish Straight at the age of 13 months.

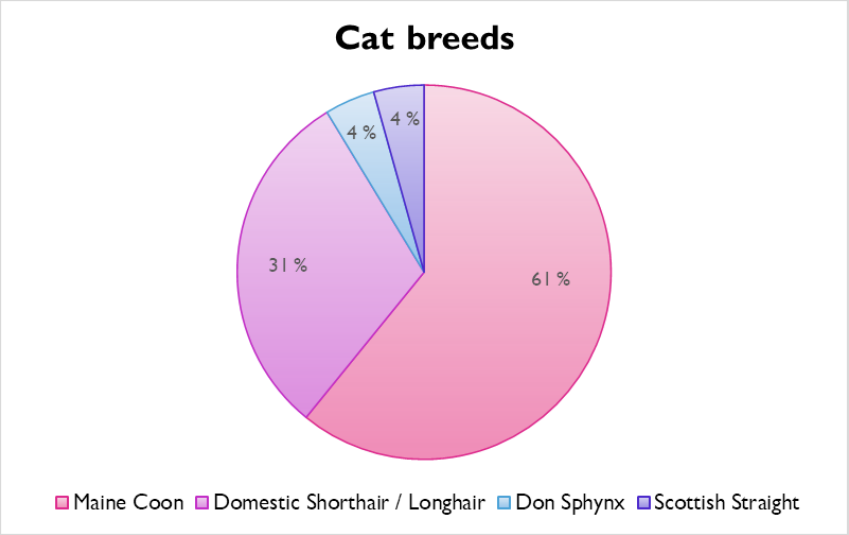

Figure 20. Proportion of the affected cat breeds

4.2.3. Oral pathologies

52% of the cats were also suffering from periodontitis and 13% from mucositis. Other concurrent oral pathologies besides hyperplastic gingivitis were alveolar bone loss (43%), at least one supernumerary tooth (22%), gingival recession (17%), supernumerary roots (13%), pyogranuloma (9%), at least one fractured tooth root (9%), an unerupted tooth (4%), malocclusion (4%), enamel discolouration (4%) and tooth resorption (4%). Four cats (17%) had only hyperplastic gingivitis and no other pathologies.

4.2.4. Clinical signs

The most common clinical signs noticed by the owner were gingival erythema (22%) and a change in eating behaviour (22%). 17% of the owners reported halitosis. Only 9% described gingival swelling. 17% of the owners had not noticed any clinical signs.

4.2.5. Location of hyperplasia

The most common site for hyperplastic gingivitis was premolar gingiva (83% of the cats). The second and third most common sites were molars (48%) and incisors (39%). The canines were the least commonly involved (35%). Five cats were missing detailed information for the exact location of hyperplastic gingiva.

4.3. Treatment options and their effectiveness

4.3.1. Resolution of the disease

There was some variability in the resolution of the disease. 44% of the cats had a complete resolution of the disease. 17% still have some clinical signs and 17% were non-responders. The confirmed response is unknown for 22% of the cats due to not being able to reach the owners, the cat was re-homed or the cat had died.

Cats who were diagnosed before the age of one year (13 cats), 38% had a good response, 8% had a good to moderate response, 8% had moderate response, 15% were non-responders, and

31% of the cat's response is unknown. Of those cats who were diagnosed at the age of 1-year old (4 cats), half of them had a good response and half had a good to moderate response. The oldest cats were 1,5 years old at the time of diagnosis (6 cats) and 50% of them had a good response, 33% were non-responders and the response is unknown for 17% of the cats.

25% of the cats had a recurrence of hyperplastic gingivitis after an initial surgical procedure. The time until a recurrence of hyperplastic gingivitis varied from 2 weeks to 6 months. The age at when the cat was declared free of the disease varied from 7,5 months to 2 years, but only 8 cats had a documentation of when exactly the oral cavity was confirmed free of hyperplastic gingivitis.

43% of the cats had severe FJHG (defined by the need for antibiotic therapy or generalized hyperplasia). 50% of the cats who had a severe condition - had a good outcome, 10% - had good to moderate outcome and 30% of them were non-responders. 10% of the outcomes are unknown.

4.3.2. Therapeutic interventions

Three cats in the study did not receive a surgical treatment. One of them received oral chlorhexidine gel on the oral mucosa and according to the owner it resolved the inflammation and further oral concerns didn't arise. One cat had a COHAT and oral homecare, which were not enough to cessate the hyperplastic gingivitis. One cat came only to a clinical examination and the owner was not able to be reached for feedback, thus the progression of this cat's oral situation is unknown.

61% of the cats had only one surgical procedure, 22% had two surgical procedures, and 4% (one cat) had eventually more than two procedures under anaesthesia. Of the cats who received one surgical intervention, 40% had a good outcome, 13% resulted in good to moderate outcome, 20% were non-responders and 27% had an unknown future. Cats who received two surgical interventions, 60% had a good outcome, 20% had good to moderate and the last 20% had moderate response. The one cat who eventually had more than two surgical interventions had a good response to treatment.

35% of the cats who underwent anaesthesia required also dental extractions because they had already developed periodontal attachment loss to the extent of requiring dental extraction at the time of the procedure i.e. the oral situation had progressed into periodontitis. Three of these cats responded to the treatment well and are currently free of oral pathologies, two of them are non-responders, and one cat's oral situation is not known. Two cats (9%) were prescribed interferon therapy besides the surgical treatment. One of them is a non-responder (has clinical signs of FCGS) and the other cat's oral situation is unknown.

The number of owners providing oral homecare was an encouraging finding as 70% of the owners performed at least some form of oral homecare for their cat at some time during the treatment period, and 52% were still continuing oral homecare at the time of last follow-up. Toothbrushing either with a toothbrush or a cotton-tipped applicator was the most popular method (48%) and the use of some oral hygiene gel was the second most popular method (43%). 35% of the owners provided both toothbrushing and an oral gel. Other options (a dental diet, a water additive) were used by 13% of the owners. Of the cats who achieved a good response to treatment, 80% received oral homecare at some point. All cats whose response was either good to moderate or moderate, received oral homecare. Of the non-responder cats, 25% had received oral homecare.

5. DISCUSSION

The topic of this thesis was chosen due to the lack of description of feline juvenile hyperplastic gingivitis and the juvenile gingivostomatitis syndrome in the literature, and the seemingly rather poor awareness of the disease. It is very important for the veterinarians to keep in mind that it is not just older cats who have oral concerns, and by discovering and intervening in the oral pathologies at an early age, the chances of progression to more severe conditions and early tooth loss are decreased.

The median age at the diagnosis found in this study (11 months) is slightly older than what is described in the literature (6-8 months). This can be partially due to that the condition may not be immediately noticed by the owner and/or the veterinarian early in the disease course, and the animals are brought to the clinic when the condition already has much more noticeable clinical signs.

There was a noteworthy breed predisposition for the Maine Coon. This is an important finding as the breed is one the most popular breeds in Finland and seems to be gaining popularity also in Estonia (Suomen Kissaliitto ry, 2020). It is likely that hereditary background proposed in the literature exists, since there seemed to be a strong breed predisposition in the study population.

Only 17% of the cats had FJHG as just the single oral pathology, which emphasizes the importance of careful investigation of the oral cavity during clinical examination of any patient. The juvenile vaccination and spay/neuter appointments are great opportunities for the veterinarian to check the oral condition and possibly notice the disease. The study also showed that the condition can cause pain and discomfort to the cat, regardless of neglect to mention this detail in the literature.

The literature provides different hypotheses about the aetiology of FJHG including a viral factor predisposing to the disease, but this was not evident in this study, although the lack of overall viral testing might be the reason for that. Of the study population, one cat was confirmed to have a feline calicivirus infection, one had a feline coronavirus infection developing into FIP disease, and one was suspected to have either feline herpesvirus or *Chlamydia felis* infection.

It's possible that more cats in the study carry a feline viral infection but due to the lack of testing them, there is no evidence to support nor disprove this theory. Often the amount of dental calculus and plaque is quite small in the affected cats, and it could be argued is there a similar immune tissue reaction to plaque and calculus in play as there seemingly is for FCGS (Lee et al. 2020).

In humans there are theories about steroid hormone levels contributing to the condition, but no such hypothesis has been presented for the feline condition. Factors of gingival hyperplasia in humans, such as the effect of steroid hormones, could be investigated in the search of aetiology and causes of feline juvenile hyperplastic gingivitis as well. It would be especially interesting to investigate is there some relation in the large size of Maine Coon cats, endocrinological imbalances (such as growth hormone), and feline juvenile hyperplastic gingivitis, as Maine Coon seems to be one the predisposed breeds to both somatotroph adenomas causing acromegaly and FJHG (Sanders et al. 2021).

Histology is the diagnostic gold standard but in a clinical setting a good diagnosis can be made based on the clinical examination, age at the onset of the disease and patient history. As histopathological diagnosis does not affect treatment in any way, it is of solely academic interest in most cases (unless clinical pattern, patient history or response to treatment would lead the veterinarian to suspect for example a neoplastic disease) and might act as a significant barrier to treatment due to added cost to the owner.

The emerging option of omega interferon therapy's efficiency should be investigated more in case of feline juvenile hyperplastic gingivitis, as to the writer's knowledge it has only been studied in Mihaljevic's study (2017) in which all cats were treated with interferon therapy without having a control group. Interferon therapy was used in two cats in our study, but they already had developed to juvenile gingivostomatitis.

This thesis provides an overview of the characteristics of the disease and the main treatment methods provided at the Estonian University of Life Sciences. Main limitations of the study are that this is a case series study and there definitely is selection bias as the university clinic is a referral clinic. There's also a lack of a control group to compare efficacies of different treatment and homecare methods. There were also sometimes missing details of patient history in the clinic software (e.g. some owners' initial complaint). It is also impossible to draw very

generalised conclusions applying to for example incidence of FJHG in either Maine Coon or wider cat population.

6. CONCLUSIONS

Feline juvenile hyperplastic gingivitis begins around the time of changing to the permanent dentition. The median age at diagnosis in our study was slightly older - 11 months. If the condition is not discovered and treated early, it can lead to the development of juvenile and subsequently adult forms of periodontitis or gingivostomatitis. 83% of the cats in our study already demonstrated other additional oral pathologies besides the feline juvenile hyperplastic gingivitis. The most common breed in the study was Maine Coon, although the disease can occur in any cat breed.

The clinical signs are distinct - enlarged and erythematous gingiva; and the diagnosis is often made based on patient history, signalment and clinical signs together with the response to therapy. 80% of the cats who had a good outcome to treatment, had at least one or two surgical procedures to remodel the gingiva. 80% of the cats with good outcome received oral homecare but not always surgical treatment. In order to get a good chance for resolution of the disease, the owner must commit to oftentimes lengthy treatment course and regular homecare.

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APPENDIXES

Appendix 1. Oral homecare products suggested to the owners for long-term prophylaxis of dental health

Toothbrush suitable for cats
Toothpaste suitable for cats
Omega fatty acid supplements
Royal Canin Dental Veterinary Diet Feline dry food
Hill's Prescription Diet Feline t/d™ Dental Care dry food
Virbac Vet Aquadent™ water additive
Virbac C.E.T. ® enzymatic chewable treats
PlaqueOff® food additive
Oral hygiene gels including chlorhexidine: Hexagel, Stomodine and Dentisept®
Oral hygiene gel including lactoferrin B: Actea ™ ORAL
Oral hygiene gel including zinc and ascorbic acic: CLUNIA® Clinical Zn-A Gel
If teeth were not being brushed, it was adviced to use several different optional products as none of the products do not have the same efficacy as toothbrushing alone.

Appendix 2. Non-exclusive licence for depositing the final thesis and opening it for the public and the supervisor's (supervisors') confirmation for allowing the thesis for the defence

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